Radiances comparisons between CERES & ScaRaB

Olivier Chomette
M. Capderou, P. Raberanto, R. Roca

19th CERES-II Science Team Meeting
May 7-9 2013

Radiances comparisons between CERES & ScaRaB

Outline

-The ScaRaB products & the availability to the public

-The ScaRaB/CERES coincidence campaign

- Comparison results

- TOA Fluxes

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The ScaRaB products

Level **1A**
1A2

→ Calibrated & geolocated TOA
TOTAL, SW & LW filtered radiances
LW=TOTAL-A'.SW

Level **2**
SEL : "ScaRaB Erbe Like"
SANN : "ScaRaB ANN"

→ **TOA SW & LW unfiltered radiances**
By unfiltering process
TOA SW & LW fluxes + albedo

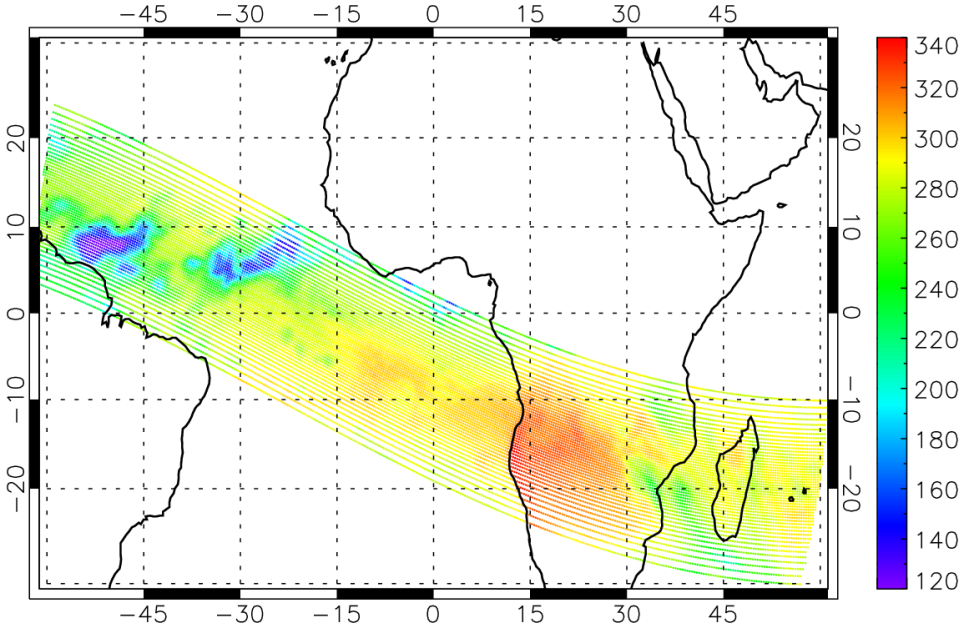
Level **2B - SANN**

→ **TOA SW & LW fluxes + albedo**
on a 1°x1° grid
instantaneous product

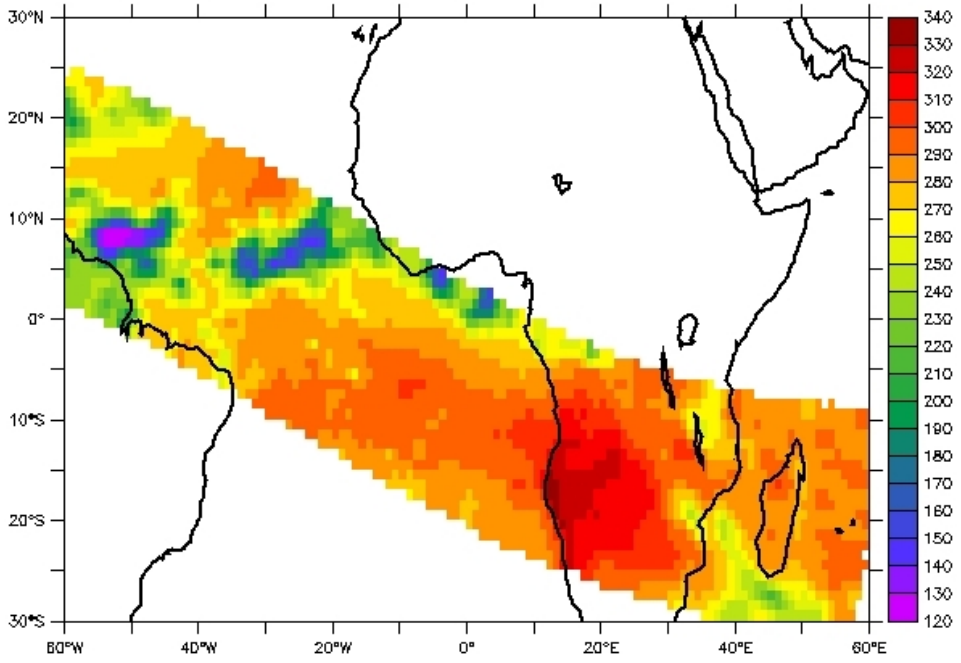
Level **4**
MCS Radiation Composite
(evolution of the energy budget during the life cycle of convective systems)

→ **MCS radiation composites per regional box and MCS class**

The ScaRaB products



Level 2 : LW Flux



Level 2B :

Instantaneous fluxes on a fixed 1° x 1° geographical grid

The ScaRaB products

Level 1A & 1A2 : Publicly available (http://www.icare.univ-lille1.fr)

Name	Collection	Version	Period
MT1SCAOL1A	0	1.04	2012-12-23 ➔ 2013-01-24
	1	1.05	2012-04-21 ➔ 2013-04-12 (still incomplete)
MT1SCAOL1A2	1	1.05	2012-04-21 ➔ 2013-04-12 (still incomplete)
MT1SCASL1A	0	1.02	2012-09-01 ➔ 2013-09-05
		1.03	2011-11-03 ➔ 2012-12-07
		1.04	2011-12-08 ➔ 2013-01-24
	1	1.05	2012-02-21 ➔ 2013-04-30 (still incomplete)
MT1SCASL1A2	0	1.03	2011-11-03 ➔ 2012-12-07
		1.04	2011-12-08 ➔ 2013-01-24
	1	1.05	2012-02-21 ➔ 2013-04-30 (still incomplete)

O = Orbit wise ; **S** = Segment wise

L1A2 = **L1A** with algorithm optimisation to improve the registration of channels.

Collection 0 : preliminary calibration result

Collection 1 : Last (but not final) calibration result + some modifications in SDS, flags.

Level 2 & 2B : Not available

Public release when V1.05 will be complete. Still some problems in Orbit wise.

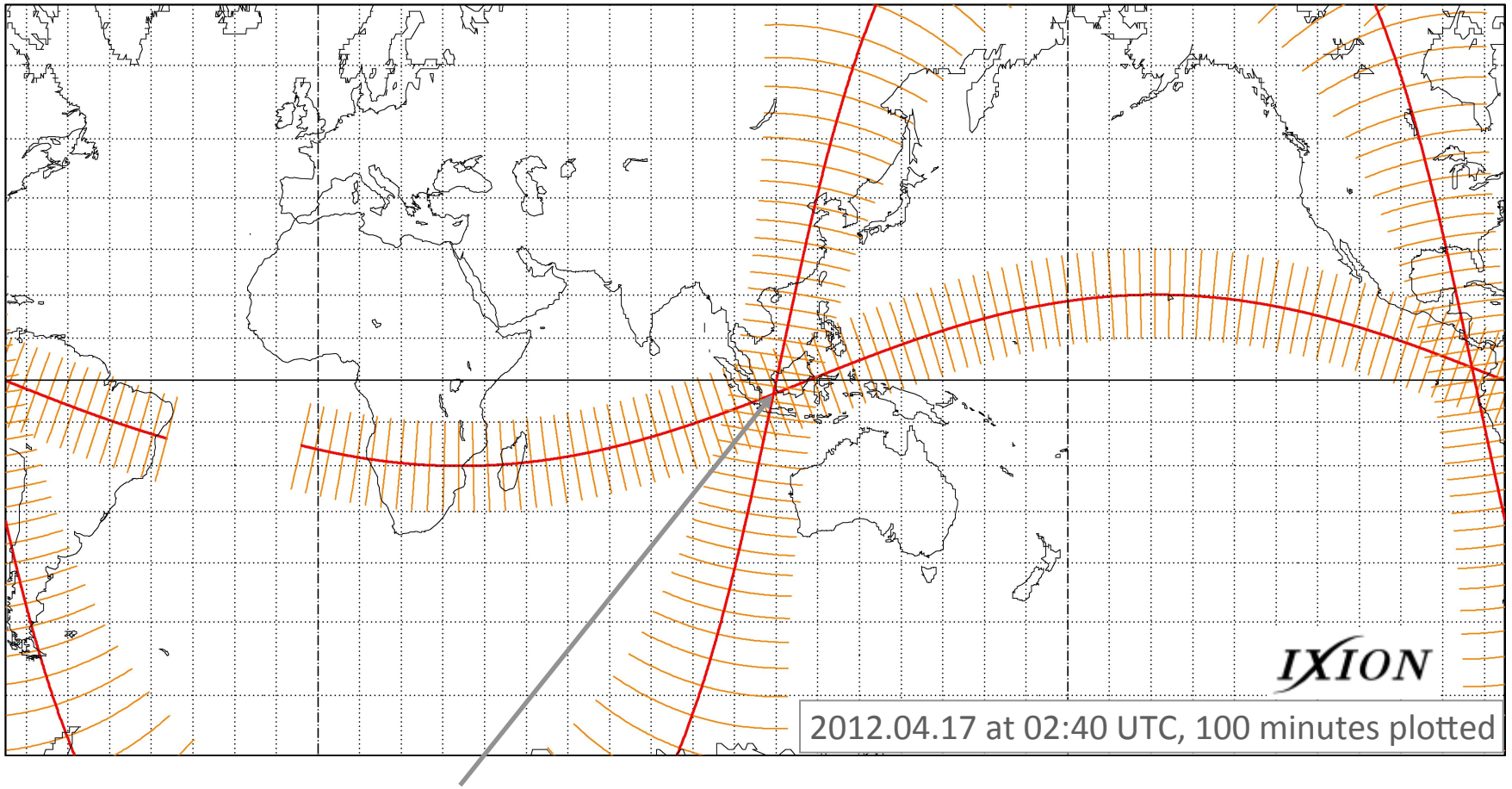
Focus on radiances comparisons between CERES & ScaRaB in this presentation.

Validation phase:
to have an idea of the accuracy of the radiances

Co-location :
Temporal (±5')
Angular (±5°)
Geographical (PSF-weighted co-location)

ScaRaB & CERES comparisons

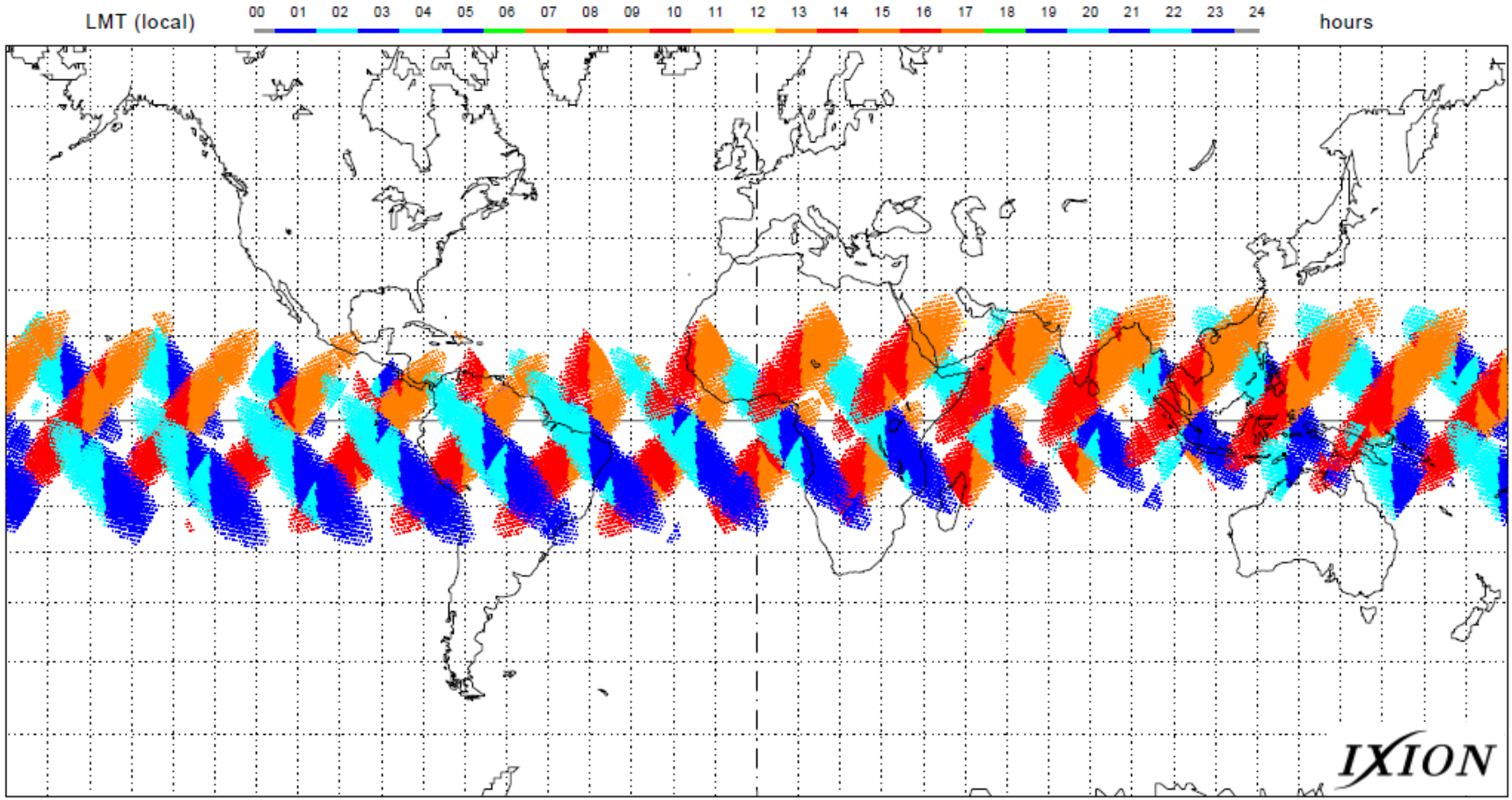
ScaRaB on MT ➔ 20° inclination, half-swath: 48.9° - XT mode
CERES on TERRA ➔ 98.2° inclination, half-swath: 55.2° - XT mode



CERES & ScaRaB crossing ; same angular conditions only near nadir.

ScaRaB & CERES comparisons

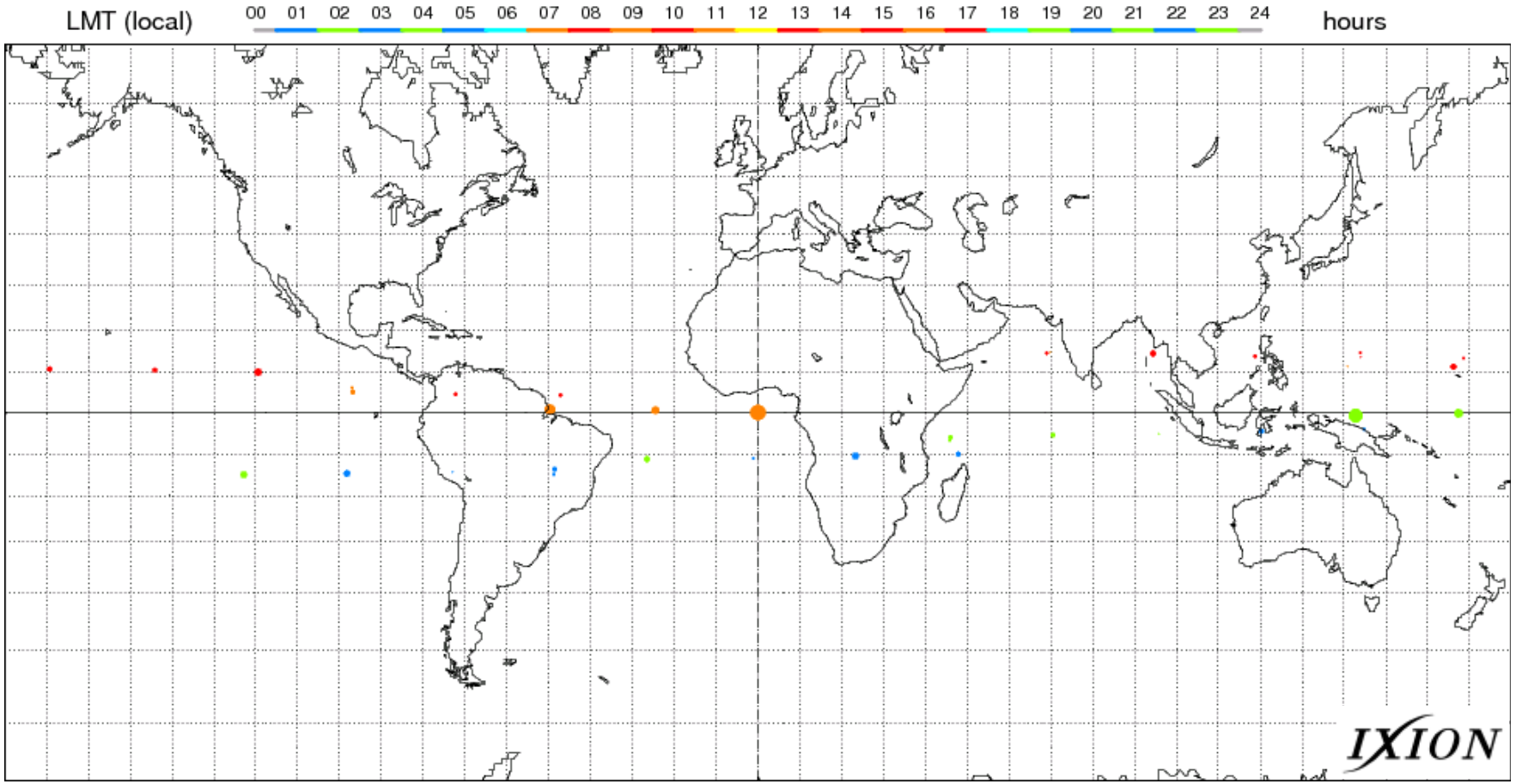
CERES/TERRA & ScaRaB/MT
Represented period : 16 days
Temporal colocation : 5’



No co-angular restriction here !

ScaRaB & CERES comparisons

CERES/AQUA & ScaRaB/MT
Represented period : 16 days
Temporal colocation : 5’
Conical aperture = **5°** ← **Angular constraint**



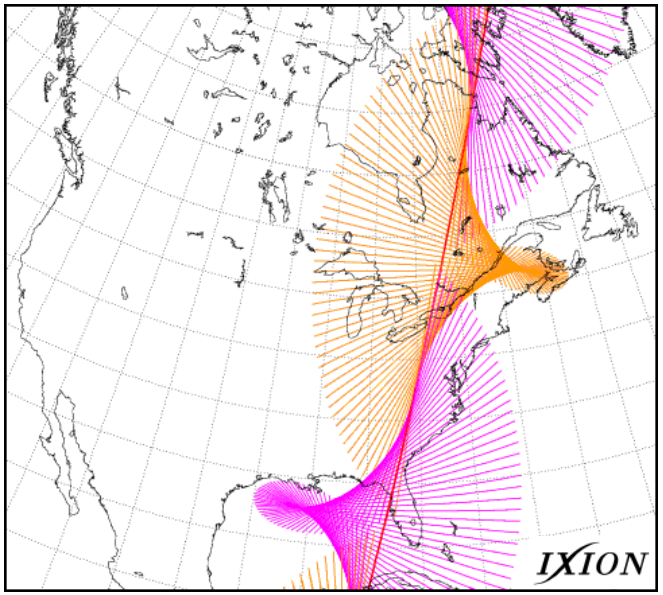
ScaRaB & CERES comparisons

In SW, it is required to have measured radiances under the same angular conditions to improve radiances matching for highly anisotropic scenes ➔ inconvenient poorer statistics in XT mode

To optimize the frequency of co-angular observations: use the CERES others scanning modes

CERES can change the angle of his axis scan.

PAPS mode: rotating angle is fixed for a required period ⟶ Possibility to align CERES and ScaRaB swaths.



CERES in RAPS mode
(Scan angle modified over time)

The CERES/ScaRaB coincidence campaign

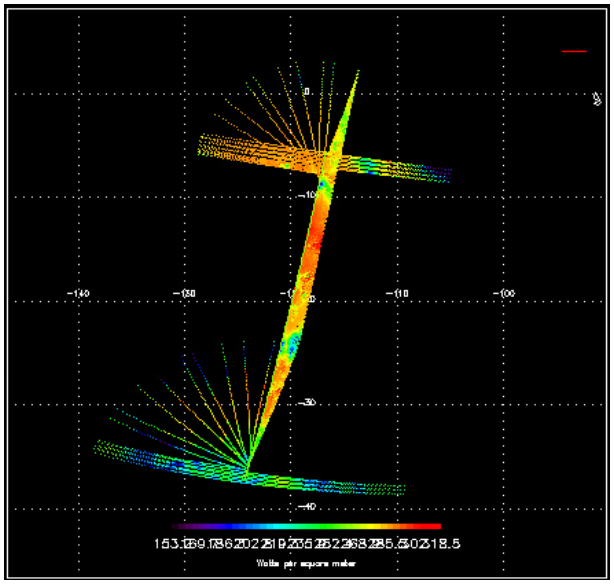
Schedule of the campaign

1 – First test on **March 31th, 2012** (FM2/TERRA in PAPS mode)

2 – PAPS mode over **51 days** (**April 17 to June 8, 2012**) for each CERES & ScaRaB crossing.

Every 7 days, we sent the prediction files to the NASA operationnal center with computed angles (computed with IXION software and the NORAD data).

3 – Checking angles after data reception.



Exemple : FM2 on PAPS mode (backward scan only)

Statistics over the campaign

Temporal colocation : ± 5'

Duration : 51 days (**daytime only**: **SW radiances**)

Angular conditions	TERRA XT (FM1)	TERRA PAPS (FM2)
Cone ± 5°	771	5817
VZA ± 5°	54974	15215

almost **7.5 times more** colocated pixels using PAPS mode.

51 days PAPS ~ 1 year XT for SW radiances + not only collocate the near nadir ScaRaB pixels

Results – PAPS campaign

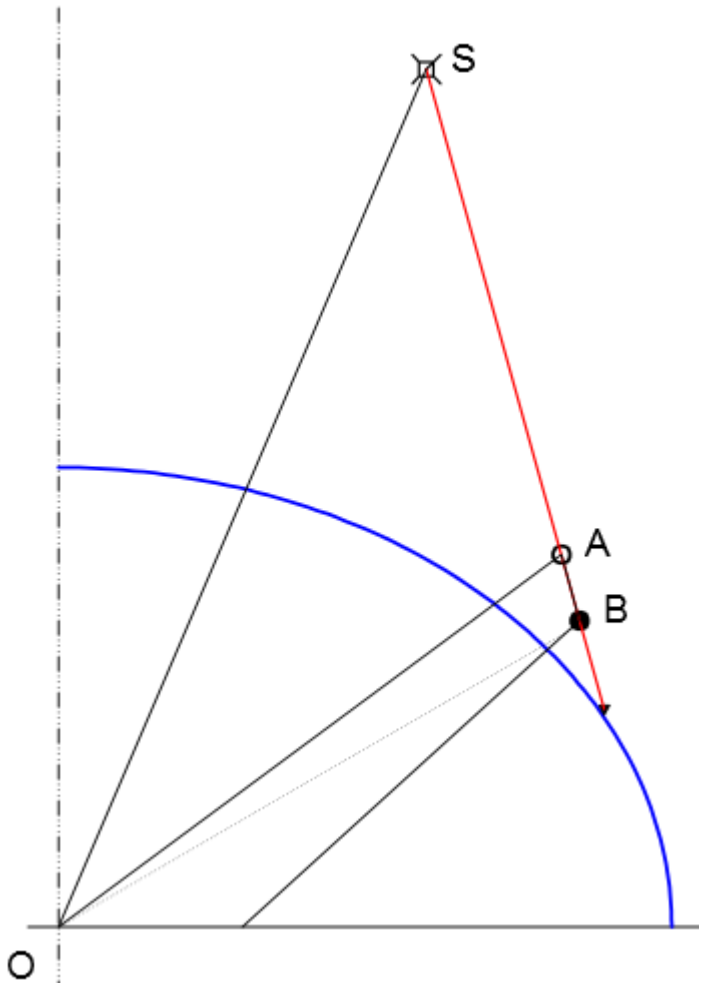
TOA at **20km**
Lat/Lon **geodetic**

ScaRaB L1A2, XT mode, Megha-Tropiques
vs.
CERES ES8, PAPS Mode, FM2 on TERRA

TOA at **30km**
Lat/Lon **geocentric**

1st step : CERES ES8 geocentric, TOA at 20km

2nd step : CERES ES8 geodetic, TOA at 20km

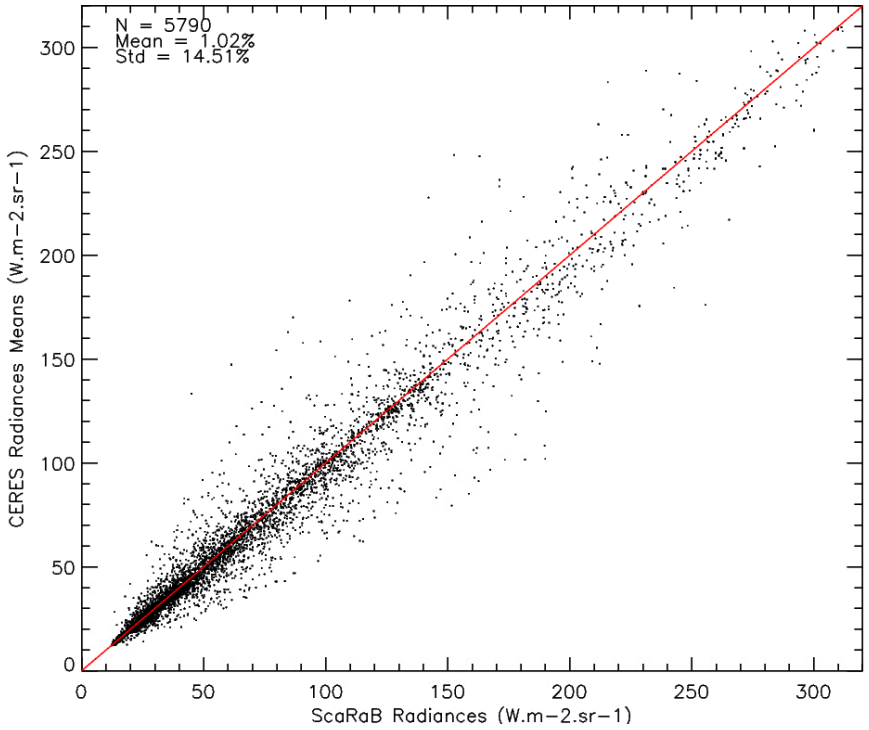


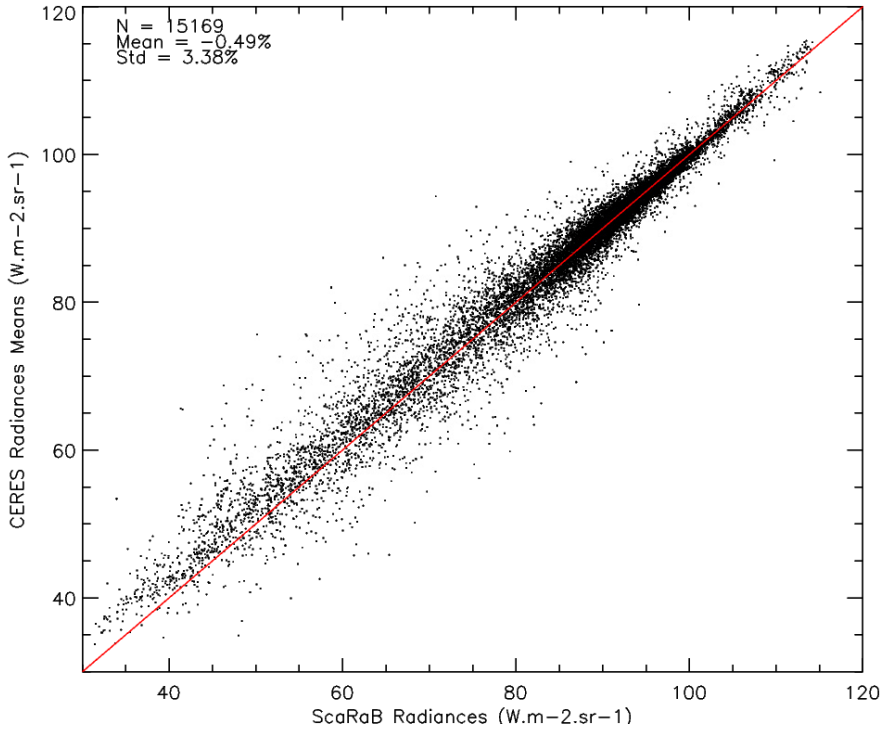
Results – PAPS Campaign

ScaRaB L1A2, XT mode, Megha-Tropiques
vs.
CERES ES8, PAPS Mode, FM2 on TERRA

(**51 days** – April 17, June 6)
5' & **5°** colocation criteria

$$diff = 100 \times \left(\frac{ScaRaB - CERES}{MEAN(CERES)} \right)$$





SW Radiances
(**5790** colocated pixels)
0.72 ± 10.17 W.m-2.sr-1
1.02 ± 14.51 % (RMS : 14.5%)

LW Radiances
(**15169** colocated pixels)
-0.42 ± 2.90 W.m-2.sr-1
-0.49 ± 3.38 % (RMS : 5.0%)

Results – PAPS Campaign

ScaRaB L1A2, XT mode, Megha-Tropiques
vs.
CERES ES8, PAPS Mode, FM2 on TERRA

SW Radiances
(**5790** colocated pixels)
0.72 ± 10.17 W.m-2.sr-1
1.02 ± 14.51 % (RMS : 14.5%)

→ Δt = ± 5'
Δθ = ± 5°
Psf =0.7

SW Radiances
(**1072** colocated pixels)
0.13 ± 9.18 W.m-2.sr-1
0.18 ± 12.59 % (RMS : 12.6%)

→ Δt = ± 2'
Δθ = ± 2°
Psf =1.0

Statistics are not surface dependent or pixels (in the ScaRaB swath) dependent
To validate ScaRaB we have to compare homogeneous pixels between them (to be sure that bias & std are not due to modification of the scene with time)

➔ Statistics over the values of $\frac{\sigma_{CERES(in\ each\ ScaraB\ pixel)}}{mean(CERES)_{in\ each\ ScaraB\ pixel}}$

Results – PAPS Campaign

ScaRaB L1A2, XT mode, Megha-Tropiques
vs.
CERES ES8, PAPS Mode, FM2 on TERRA

$\frac{\sigma_{CERES}}{mean(CERES)}$	N	$\frac{ScaRaB - CERES}{mean(CERES)}$ (%)
0- 5%	1518	0.89 ± 9.21
5-10%	1516	1.25 ± 13.20
10-15%	1045	1.50 ± 14.67
15-20%	636	1.93 ± 16.67
20-25%	429	0.31 ± 19.64
25-50%	610	-0.59 ± 21.91
50-100%	36	-3.85 ± 32.31
0-100%	5790	1.02 ± 14.51

Psf > 0.7 – 5min – 5°

ScaRaB L1A2, XT mode, MT vs. CERES SSF, XT Mode, FM1 & FM3 (PAPS period)

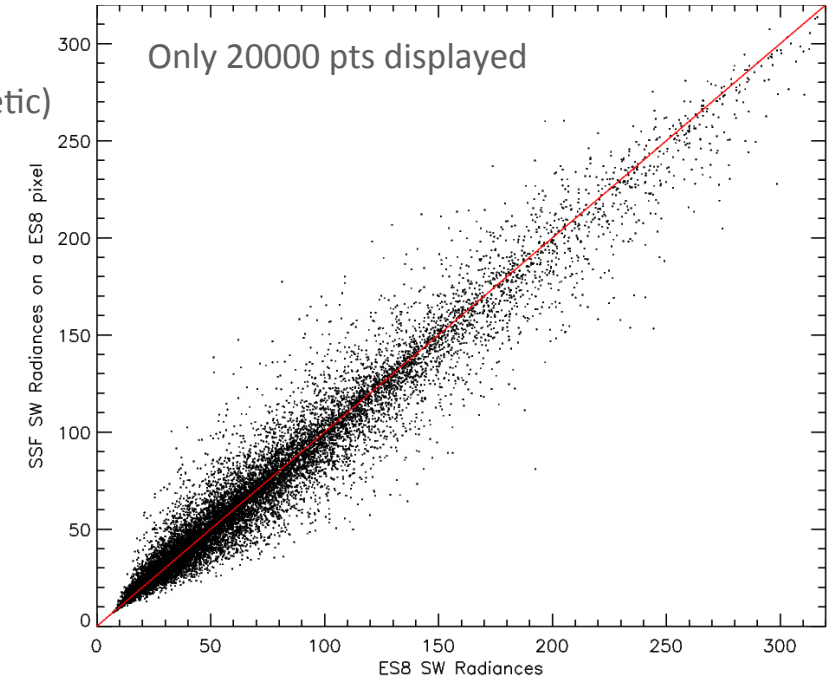
	SW Radiances TERRA (FM1-SSF)			SW Radiances AQUA (FM3-SSF)
0- 5%	189	1.76 ± 3.46	144	4.09 ± 3.56

Psf > 0.7 – 5min – 5°

Results

CERES ES8, PAPS Mode, **FM2** on TERRA (geodetic)
vs.
CERES SSF, XT Mode, **FM1** on TERRA

SW Radiances
(**3103865** colocated pixels)
0.14 ± 9.72 W.m-2.sr-1
0.23 ± 15.90 % (RMS : 15.9%)



Comparison over these 51 days.
Same colocation criteria, same algorithm.

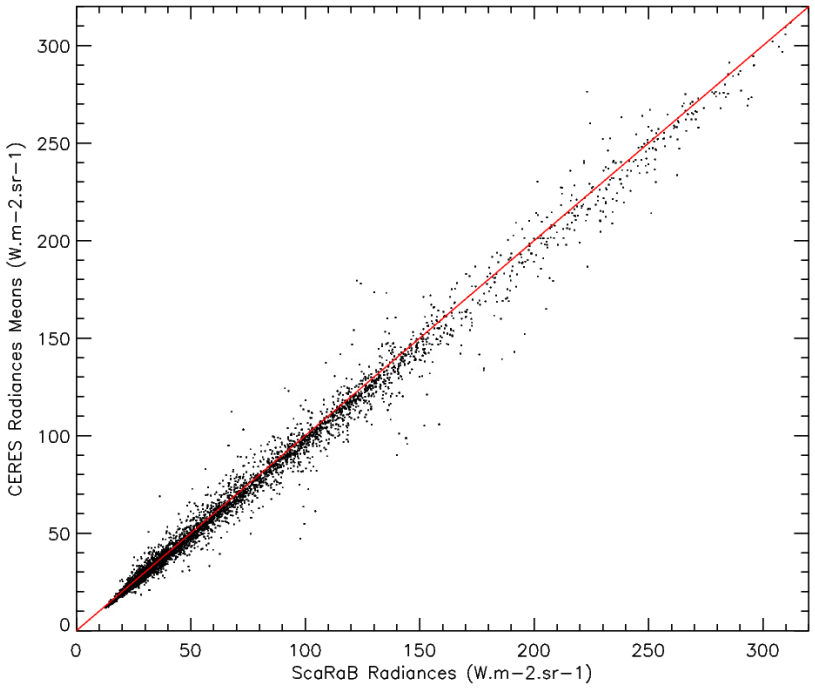
Small biais but large std.

Geocentric/geodetic has been fixed but are we missing something else ?

When comparing same instrument with overlaping pixels with himself, our method brings std.

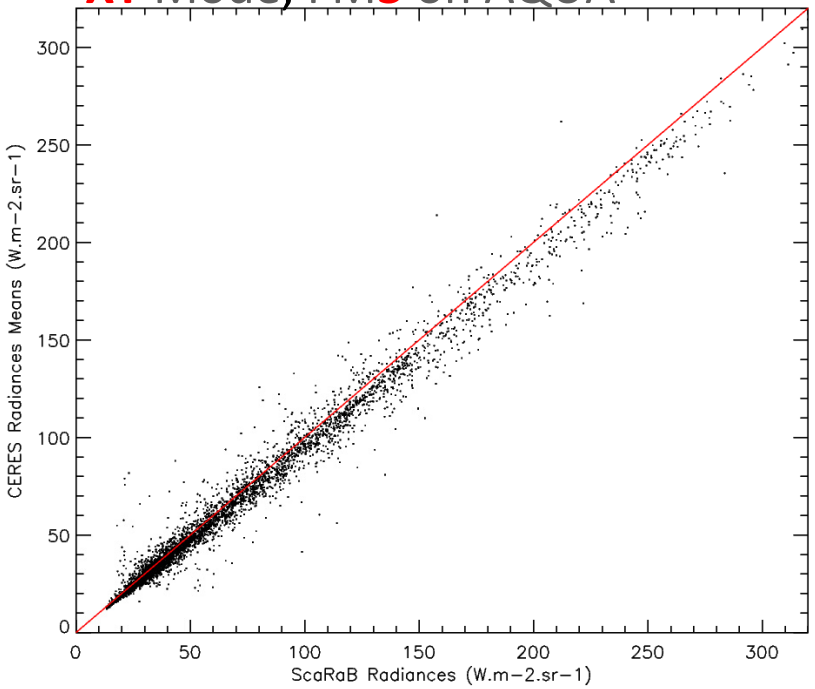
Results : YEAR 2012

ScaRaB L1A2, XT mode, MT
vs.
CERES **Flash Flux**,
XT Mode, FM**1** on TERRA



SW Radiances
(**4977** colocated pixels)
2.24 ± 8.96 % (RMS : 9.2%)

ScaRaB L1A2, XT mode, MT
vs.
CERES **Flash Flux**,
XT Mode, FM**3** on AQUA



SW Radiances
(**4933** colocated pixels)
3.96 ± 9.90 % (RMS : 10.7%)

Results : YEAR 2012

ScaRaB L1A2, XT mode, MT
vs.
CERES **Flash Flux**,
XT Mode, FM**1** on TERRA

ScaRaB L1A2, XT mode, MT
vs.
CERES **Flash Flux**,
XT Mode, FM**3** on AQUA

	SW Radiances TERRA		SW Radiances AQUA	
$\frac{\sigma_{CERES}}{mean(CERES)}$	N	$\frac{ScaRaB - CERES}{mean(CERES)}$ (%)	N	$\frac{ScaRaB - CERES}{mean(CERES)}$ (%)
0- 5%	1106	1.80 ± 4.89	949	4.50 ± 4.13
5-10%	1010	2.43 ± 6.28	923	4.32 ± 6.78
0-100%	4977	2.24 ± 8.96	4933	3.96 ± 9.90

Psf > 0.7 – 5min – 5°

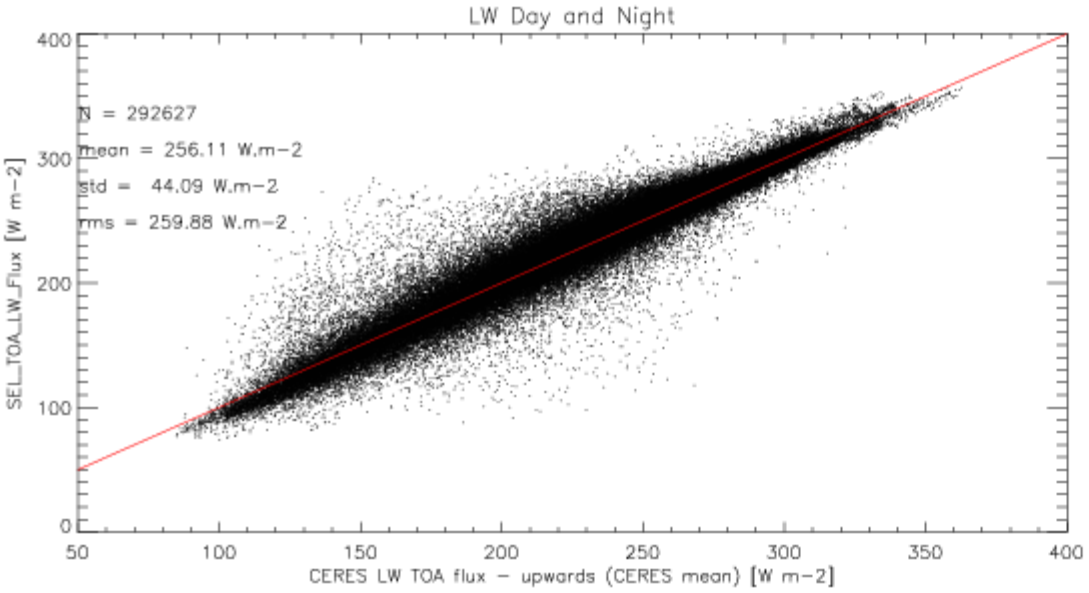
Higher bias with AQUA than with TERRA

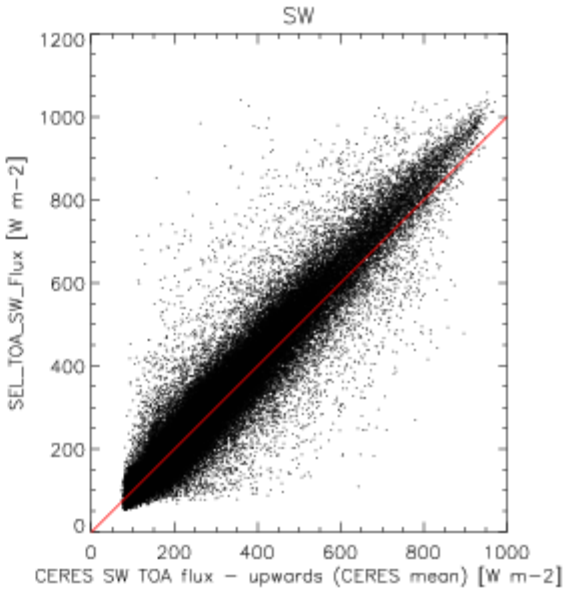
Results : TOA FLuxes

-Same work has been done for TOA Fluxes in order to validate our algorithms.

➔ More colocated pixels between CERES & ScaRaB (no angular constraint).
➔ Comparisons between SEL (ScaRaB Erbe Like) and ES8
➔ Comparisons between SANN (ScaRaB Artificial Neural Network) and SSF

SEL vs ES8 – 12/2011



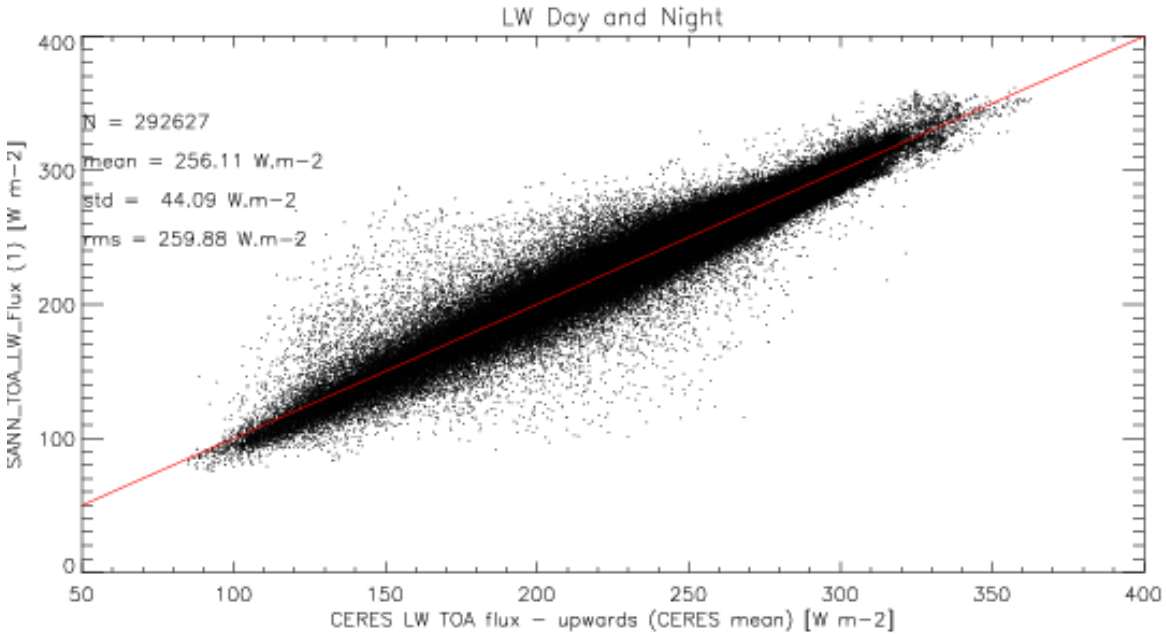


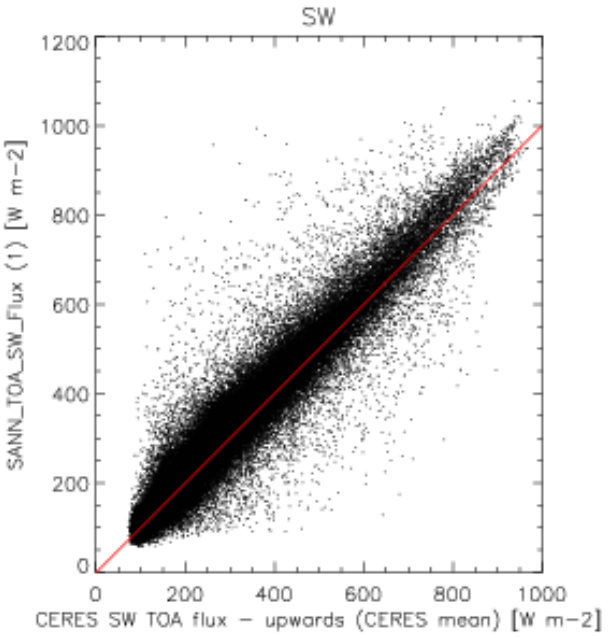
TOA **LW** Fluxes
(**292627** colocated pixels)
0.15 ± 4.95 % (RMS : 5.0%)

TOA **SW** Fluxes
(**147567** colocated pixels)
1.93 ± 18.92 % (RMS : 19.0%)

Results : TOA FLuxes

SANN vs SSF – 12/2011



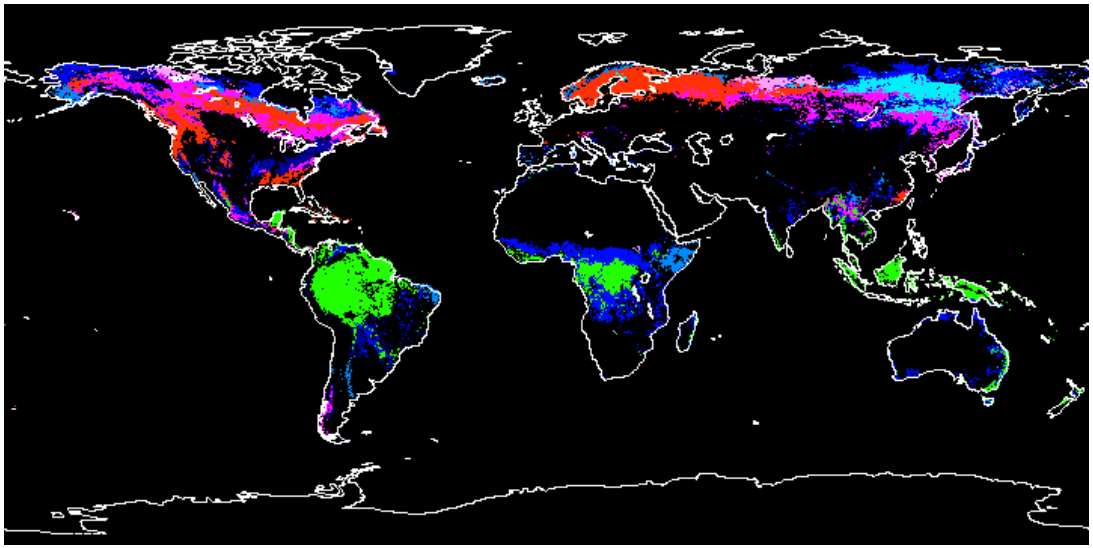


TOA **LW** Fluxes
(**292627** colocated pixels)
-0.29 ± 5.22 % (RMS : 5.2%)

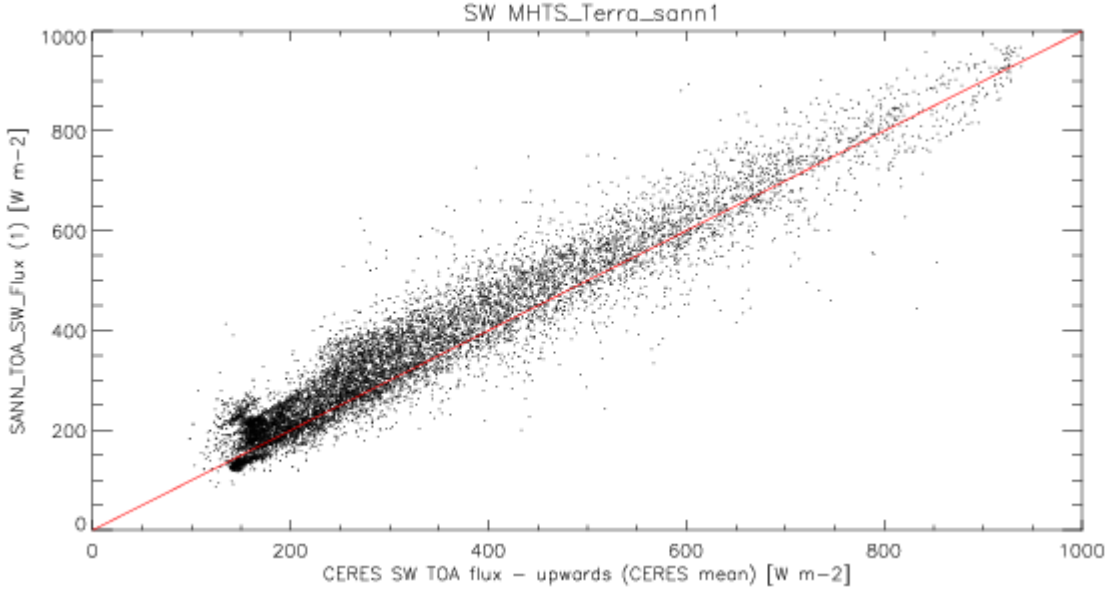
TOA **SW** Fluxes
(**147567** colocated pixels)
6.40 ± 18.09 % (RMS : 19.2%)

All pixels here. No homogeneity criteria.
Unlike radiances dependence on surfaces types.

Results : TOA FLuxes



Land MHTS (Medium to High Tree/Shrubs)



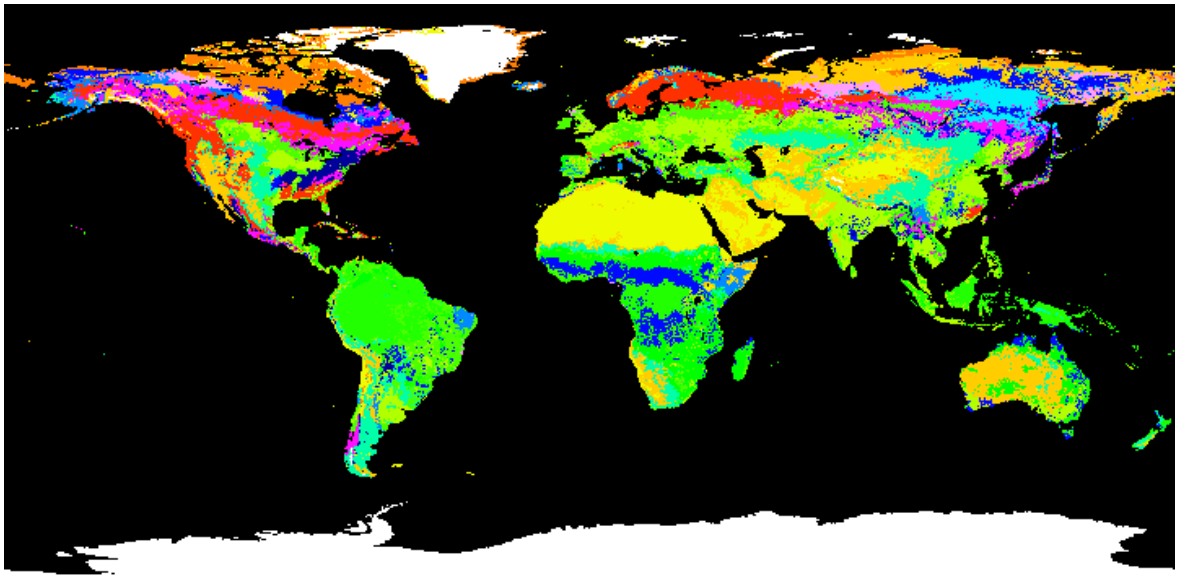
TOA **SW** Fluxes
(**12111** colocated pixels)
10.8 ± 18.0 % (RMS : 21.0%)

Results : TOA FLuxes

SANN has been developed with CERES-TRMM data (and we used the CERES-TRMM surface types ➔ **ADM Id**)

6 different algorithms, one for each surface type (Ocean, oceanglint, DD, BD, LMTS, MHTS

➔ Improper determination of surface type leads to a wrong use of neural networks.



SANN is used with IGBP Surface Map

MHTS = IGBP 1, 2, 3, 4, 5, 6, 8 & 11

How surface types in ADM-Id have been determined for CERES-TRMM ?

Are we using the same IGBP data ?

Comparisons in XT mode all along MT mission to analyse the possible drifts between instruments.

All these calculations will be revised after the final version of the calibration.

Use of GERB to do the same work.

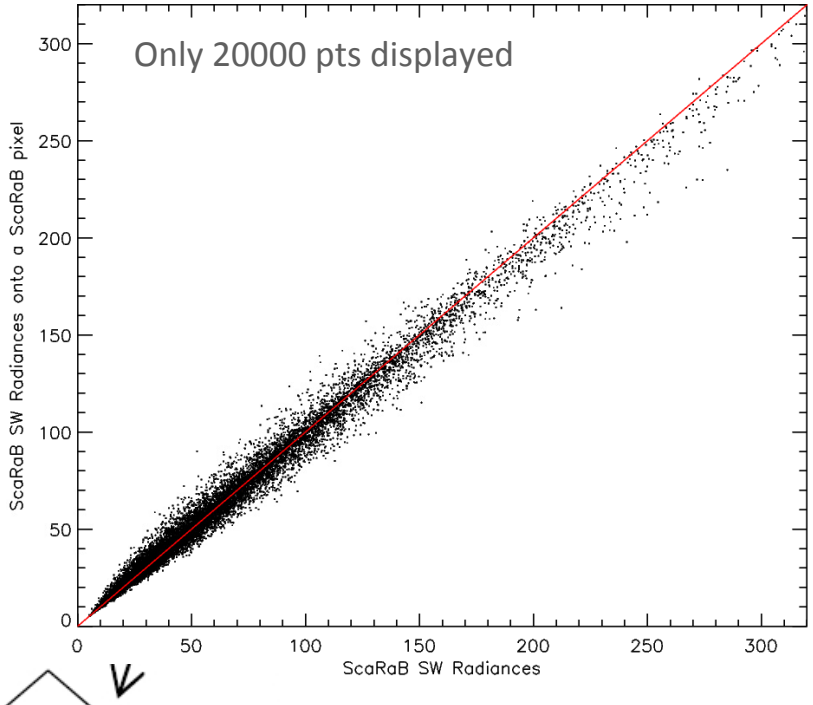
All these comparisons are instantaneous comparisons.

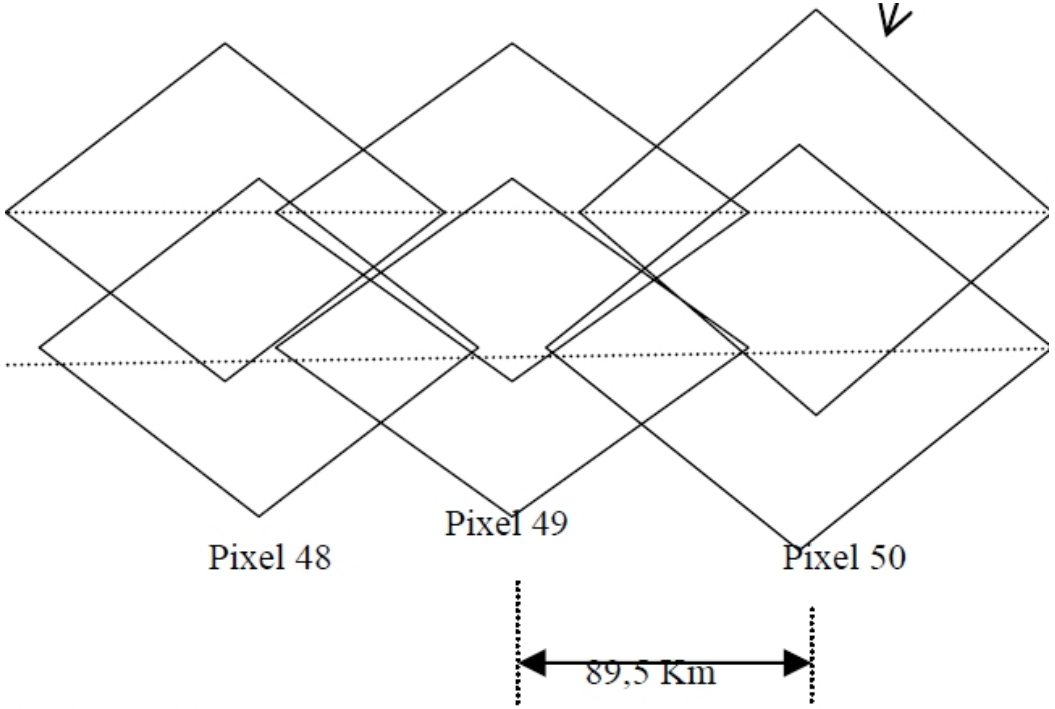
Thank You

Results

ScaRaB L1A2, XT mode, MT
vs.
ScaRaB L1A2, XT mode, MT

SW Radiances
(**2545273** colocated pixels)
0.14 ± 9.72 W.m-2.sr-1
-0.02 ± 9.38 % (RMS : 9.4%)





How to validate the radiances

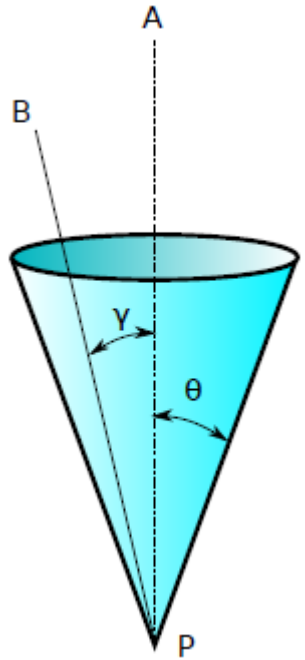
- No in-situ measurements
- Comparisons with another ERB instruments

  Pixels colocation: geographical, temporal and angular (because of the anisotropy of the observed scenes).

SW radiances

Co-angular ($\theta_{zenith} \pm x°$ & $\theta_{azimuth} \pm x°$ or conical aperture with an aperture of x°)

Simultaneous ($\Delta T \pm x$ mn)

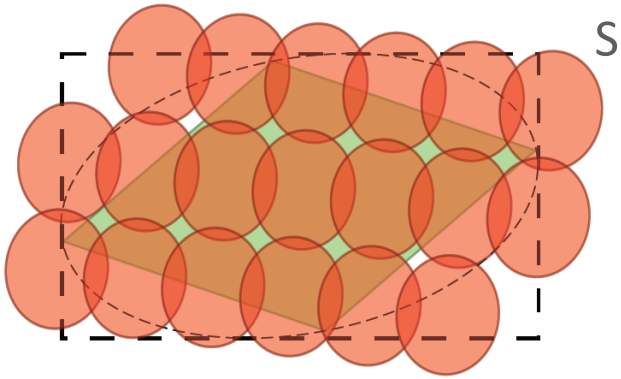


LW radiances

Same as SW without the $\theta_{azimuth}$ constraint

How to validate the radiances

- Spatial colocation

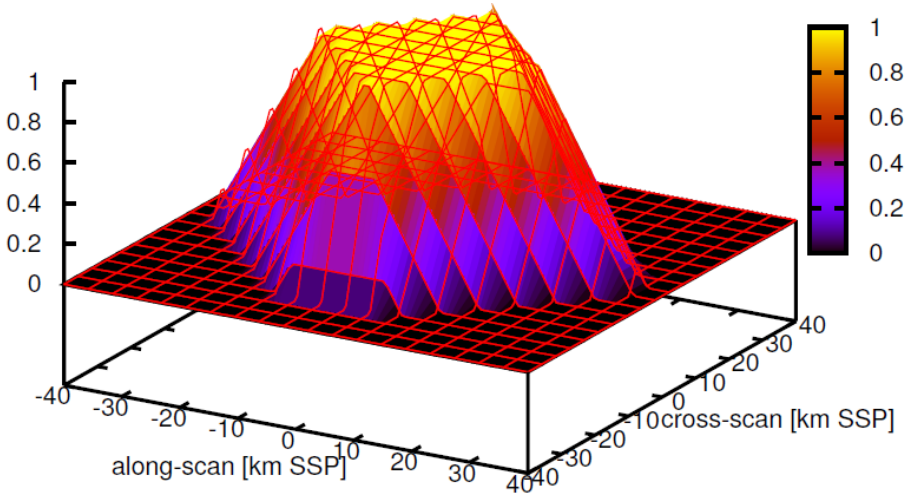


ScaRaB **(green)** = master pixel ; CERES **(red)** = slave pixel

Pixels with different sizes, shapes and weighting functions

The deformation of the pixels are taken into account

The PSF-weighted co-location estimates the contribution of each slave **(red)** pixel inside the master **(green)** one



Exemple of ScaRaB PSF

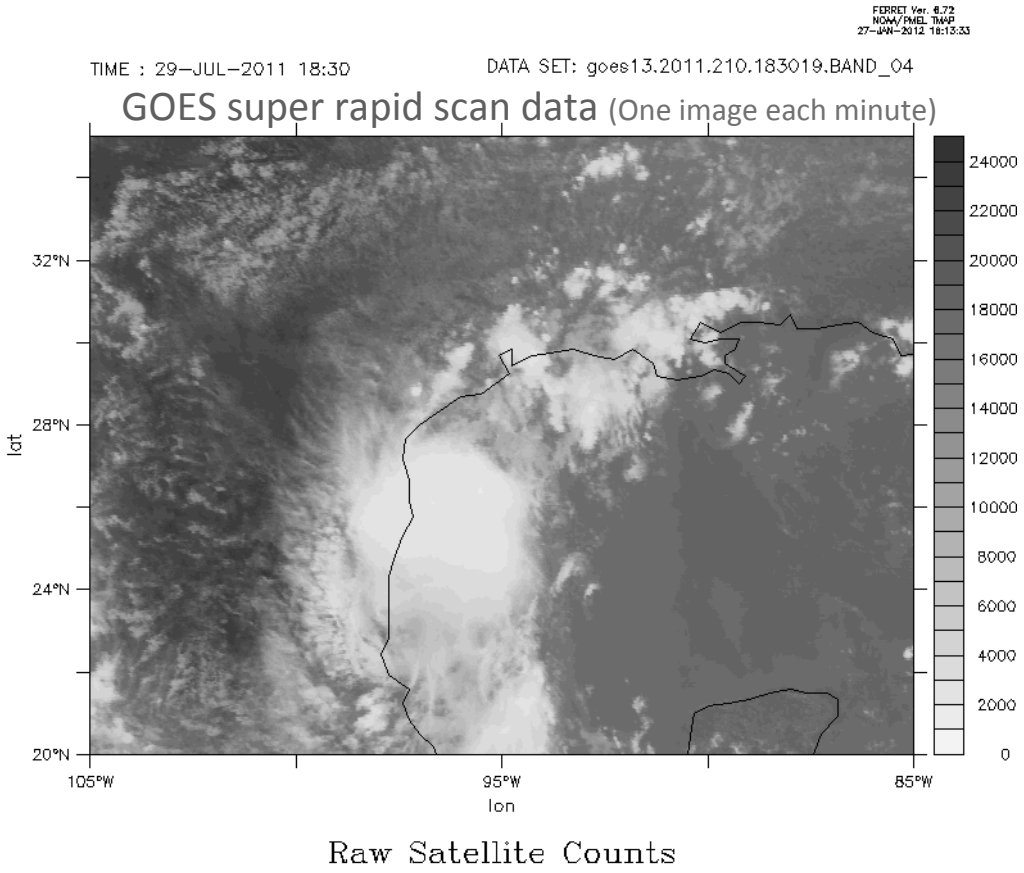
Comparisons between an averaged value (from CERES pixels into a ScaRaB pixel) and the ScaRaB measurement.

How to validate the radiances

- Angular colocation

ADM bin angles : 10°
Clerbaux et al. : ± 5°

5°
Aperture of the cone



- Temporal colocation

Szewczyk et al. ; Clerbaux et al. :
± 7.5 min.

Possible to increase this value ?

Study ScaRaB pixels behavior with time using GOES SRS

5 minutes
Temporal Colocation